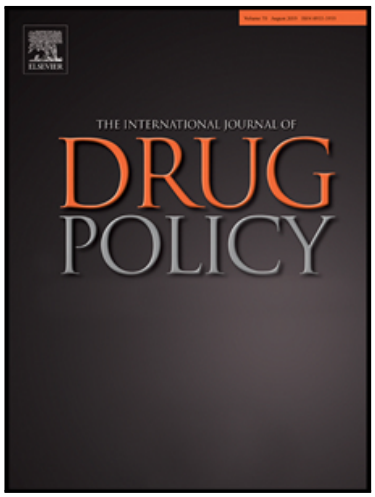
Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.



Examining Reactions to Smoking and COVID-19 Risk Messages: An Experimental Study with People Who Smoke

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Highlights

- Growing evidence suggests smoking cigarettes worsens COVID-19 outcomes, but few studies have examined the effects of this information on people who smoke.
- Our experiment randomized 1,004 adults who smoke into one of four message conditions: COVID-19 risk, smoking risk, combined risk of smoking for COVID-19 severity, or a non-risk control.
- Results showed that messages about worse outcomes of COVID-19 for people who smoke increased the perceived severity of smoking-related disease (vs. non-risk control messages) and intentions to quit smoking (vs. COVID-19 risk messages) or intentions to reduce smoking (vs. smoking risk messages and control messages).
- Exposure to the combined risk messages (vs. control) was associated with higher odds of mask-wearing intentions in the next 2 weeks.
- This the first study (to our knowledge) to demonstrate that messages about the increased risk of smoking for COVID-19 severity impacted both smoking and COVID-protective intentions.
- Our findings suggest that messages about the combined risk of smoking and COVID-19 may be a promising strategy to reduce smoking intentions and increase intentions to protect against COVID-19.

Examining Reactions to Smoking and COVID-19 Risk Messages: An Experimental Study with People Who Smoke

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Abstract

Background: Smoking cigarettes worsens COVID-19 outcomes, and news media and health agencies have been communicating about that. However, few studies have examined how these messages affects attitudes, beliefs, and behavioral intentions of people who smoke. These are critical variables that can inform public health campaigns to motivate quitting smoking during the COVID-19 crisis.

Methods: In August 2020, we conducted an online experiment in the U.S. with 1,004 adults who smoke. Participants were randomized to one of four message conditions: COVID-19 risk, smoking risk, combined risk of smoking for COVID-19 severity, or a non-risk control. Outcomes were message reactions (emotions and reactance), attitudes and beliefs (severity, susceptibility, self-efficacy, response efficacy for smoking and COVID-19, and conspiracy beliefs), and behavioral intentions (smoking intentions, COVID-protective intentions, and information-seeking).

Results: Multivariate analysis of covariance (MANCOVA) showed that combined risk messages elicited higher perceived severity of smoking-related disease than control messages. Similarly, the combined risk condition resulted in greater intentions to quit smoking in the next month (vs. COVID-19 risk condition) and intentions to reduce smoking in the next 6 months (vs. smoking risk and control; *ps* < .05). Multivariate logistic regression found that exposure to the combined risk messages (vs. control as referent) was associated with higher odds of mask-wearing intentions in the next 2 weeks (AOR = 1.97).

Conclusions: Health agencies can possibly use messages that communicate about the combined risk of smoking and COVID-19 as a novel strategy to motivate people who smoke to quit and take protective action for COVID-19.

Introduction

The novel Coronavirus Disease 2019 (COVID-19) outbreak has caused widespread sickness and death (Johns Hopkins University & Medicine, 2021). A growing body of evidence has shown that smoking cigarettes increases the severity of COVID-19 (Gülsen et al., 2020; Karanasos et al., 2020; Patanavanich & Glantz, 2020; Reddy et al., 2021; Zhao et al., 2020) and governmental and public health agencies, such as the Food and Drug Administration, the Centers for Disease Control, and the World Health Organization, have designated smoking a risk factor for COVID-19 (Centers for Disease Control and Prevention, 2021; U.S. Food and Drug Administration, 2021; World Health Organization, 2020). Emerging studies show a spectrum of awareness among people who smoke on the greater severity of COVID-19 for them, with some (particularly those in the process of quitting) being highly cognizant of the increased severity and some reporting not having heard of it (Popova et al., 2021; Rigotti et al., 2021).

Awareness about the increased severity of COVID-19 for people who smoke has been associated with greater smoking quit intentions in cross-sectional research (Elling et al., 2020; Klemperer et al., 2020; Kowitt et al., 2020). However, it is unclear how exposure to such information might affect emotional and cognitive responses and behavioral intentions of people who smoke. Few studies have tested reactions to messages about the risk of smoking for COVID-19 severity. Grummon et al. (2020) exposed people who smoke and/or use e-cigarettes to messages about the risk of smoking (or e-cigarette use) for worsened COVID-19 outcomes presented as tweets from the Centers for Disease Control. Compared to the control messages (generic information about cigarettes), messages containing smoking risk or risk of increased severity of COVID-19 produced higher scores on perceived message effectiveness to discourage participants from smoking. However, the study primarily focused on perceived message

effectiveness and did not measure outcomes related to quitting smoking or protecting against COVID-19. Pettigrew et al. (2021) tested four messages for smoking cessation (two were COVID-focused, one was on respiratory health, and one was financially focused) and found that exposure to COVID messages significantly increased intentions to quit smoking, compared to the other messages. This study was conducted with participants from Australia, New Zealand, and the United Kingdom, and thus testing still needs to be done in the U.S.

There have been calls for more research to understand how media exposure about the risks of smoking for COVID-19 impacts people who smoke (Berlin et al., 2020; Eisenberg & Eisenberg, 2020; Popova, 2020). To heed these calls, we tested the effects of messages about smoking and COVID-19 risks, with the risks presented separately and together. Based on past research (Francis et al., 2019; Yang & Popova, 2019), the message impact framework informed our selection of outcomes (Noar et al., 2016). The message impact framework argues that message characteristics influence receivers' reactions to warnings (e.g., emotions), affecting attitudes and beliefs, and behavioral intentions (Noar et al., 2016). These individual outcomes (message reactions, attitudes and beliefs, and intentions) are theorized to be predictors of behavioral change (Noar et al., 2016). Evaluating antecedents to behavioral change is important to understand how health communication interventions might impact consumer behaviors. Thus, the message impact framework guided our study as we evaluated message reactions, attitudes and beliefs, and behavioral intentions after exposure to risk messages.

Our research question sought to understand how exposure to messages about risks of smoking and/or COVID-19 might affect participants' message reactions, attitudes and beliefs, and behavioral intentions about quitting smoking and protecting against COVID-19. These outcomes were assessed in an online experiment where adults who smoke were randomly

assigned to different risk messages about smoking and COVID-19 to evaluate the exposure effects of the risks presented together and separately.

Methods

Participants

In August 2020, a convenience sample of 1,004 U.S. adults (18+ years old) who currently smoke were recruited by the market research company Toluna (www.toluna-group.com). Although not a representative survey, participants were invited to participate based on quotas on gender, age, education, race, and income categories that approximate the distributions in the national population. In calculating the sample size, we estimated the final sample we needed (200 participants per condition, 1,000 total), and the research company recruited the participants until that number was reached. Toluna uses multiple online strategies (e.g., web banners, website referrals, affiliate marketing) to recruit eligible participants for research. Inclusion criteria for the study were being 18 years old or older, having smoked 100 cigarettes in their lifetime and currently smoking cigarettes every day or somedays, and being able and willing to participate in study conducted in English. All participants completed an electronic informed consent. The Georgia State University Institutional Review Board approved the protocol.

Procedure and Design

We conducted a pilot test with 100 participants to test the feasibility and readability of the questionnaire. The study was an online experiment administered through the Toluna system. After consenting, participants reported their demographics and answered pretest questions about smoking quit intentions, health status, and previously having COVID-19. Participants were then randomized to one of four conditions: (1) COVID-19 risk, (2) smoking risk, (3) combined risk (i.e., smoking increases COVID-19 severity), and (4) control. To prevent case-category

confounding issues (Jackson et al., 2006), each condition had five messages, and participants were randomly exposed to one of the five messages in each condition. After viewing the message, participants responded to the outcome measures (detailed below and in Table 1). They were also asked to report how many people they knew who had COVID-19 and if they had heard about the risk of COVID-19 for smokers before participating in the study. Finally, participants were debriefed that the messages they had seen were used for research purposes only and had not been approved by any public health or federal agency, shown information about the increased severity of COVID-19 for tobacco users (Toolkit, 2020), and provided with a smoking quitline number and links to smoking cessation websites.

Message Stimuli

We created the experimental stimuli (e.g., messages) by adopting content from news stories (e.g., *ABC*, *New York Times*, and *Fox News*) and educational campaigns about smoking risks (Centers for Disease Control and Prevention, 2016). Each message was formatted like an online news story and had a headline, a color photo, and was approximately 150 to 250 words in length. No references to any specific journalists or news outlets were included to prevent possible confounding effects of message credibility. Messages in the COVID-19 risk condition focused on disease progression (lung failure, heart damage, and death). Messages in the smoking risk condition described negative health impacts of smoking (lung and heart disease, cancer, and death). The combined risk condition described how smoking makes COVID-19 worse. The control condition showed non-risk messages (e.g., facts about whales).

All messages in the risk conditions ended with an efficacy paragraph emphasizing possible ways to deal with described risks, including quitting smoking, engaging in COVID-protective behaviors—or both. Efficacy is a key factor influencing how message receivers

respond to fear appeals (Witte, 1994). Arousing fear without eliciting efficacy to deal with the risk can lead to rejection of the warning message, possibly harming public health (Ruiter et al., 2014). Therefore, we included a brief efficacy component with each risk message (see Figure 1 for example messages; see supplemental materials for all study messages).

Key Measures

Based on the message impact framework, we assessed three sets of outcomes (full definitions provided in Table 1).

1. Message reactions: negative and positive emotions (Nonnemaker et al., 2010; Popova et al., 2018) and psychological reactance (Hall et al., 2017).
2. Attitudes and beliefs: susceptibility and severity (for smoking-related disease and COVID-19 each), self-efficacy and response efficacy (for smoking and COVID-19 each; El-Toukhy, 2015) and COVID-19 conspiracy beliefs (Imhoff & Lamberty, 2020).
3. Behavioral intentions: smoking quit intentions next 1 month (Carpenter et al., 2003), smoking intentions next 6 months (Wong & Cappella, 2009), COVID-19 information-seeking intentions (Kelly & Hornik, 2016; Shim et al., 2006), COVID-protective intentions next 2 weeks (Mays et al., 2016; Yang & Popova, 2019).

Table 1. *Measures and definitions of dependent variables*.

Key Variables	**Response Options**	**Reliability**
1. Message Reactions (set 1)		
Emotional reactions While looking at the messages, I felt: *Negative:* sad, angry, afraid, guilty, disgusted, worried, ashamed *Positive:* amused, hopeful	1 (not at all) – 9 (extremely)	α = .89 *r* = .45 (*p* < .001)
Psychological Reactance - The information in the news article is overblown - The news story is trying to manipulate me	1 (not at all) – 9 (extremely)	α = .86

Key Variables	Response Options	Reliability
- The news story annoys me		
2. Attitudes and Beliefs (set 2)		
Perceived Smoking Severity - If you develop a smoking-related disease, how severe or serious will it be?	1 (not at all) – 9 (extremely)	Analyzed separately
Perceived Smoking Susceptibility - How likely is it for you to develop a smoking-related disease?	1 (not at all) – 9 (extremely)	Analyzed separately
Perceived COVID-19 Severity - If you catch COVID-19 (coronavirus), how severe or serious will it be?	1 (not at all) – 9 (extremely)	Analyzed separately
Perceived COVID-19 Susceptibility - How likely is it for you to catch COVID-19 (coronavirus)?	1 (not at all) – 9 (extremely)	Analyzed separately
Smoking Self-efficacy - If you decided to give up smoking completely in the next 6 months, how sure are you that you would succeed? - It is easy for me to quit smoking	1 (not at all) – 9 (extremely)	$r = .50$ ($p < .001$)
Smoking Response efficacy - How much do you think you would benefit from health and other gains if you were to quit smoking permanently in the next 6 months? - Quitting smoking is effective in preventing cancer	1 (not at all) – 9 (extremely)	$r = .55$ ($p < .001$)
COVID-19 Self-efficacy - It is easy for me to stay safe from COVID-19 I feel confident I can: - Wear face mask in public - Wash my hands frequently - Practice social distancing	1 (not at all) – 9 (extremely)	$\alpha = .76$
COVID-19 Response Efficacy (effectiveness of mask, wash hands, social distance) How effective are the following measures at preventing	1 (not at all) – 9 (extremely)	$\alpha = .85$

Key Variables	Response Options	Reliability
COVID-19? - Wear face mask in public - Hand washing with soap and water - Social distancing		
COVID-19 Conspiracy Beliefs - Experts intentionally mislead us for their own benefit, even though the coronavirus is not worse than a flu. - Coronavirus was intentionally brought into the world to reduce the population.	1 (strongly disagree) – 9 (strongly agree)	Analyzed separately
3. Behavioral Intentions (set 3)		
Smoking quit intentions next 1 month - How much do you intend to quit smoking in the next month?	0 (definitely no) – 10 (definitely yes)	Analyzed separately
Smoking intentions next 6 months How likely is it that in the next 6 months you will: - Reduce the number of cigarettes you smoke in a day - Use nicotine gum, nicotine patch, or other forms of nicotine replacement therapy - Seek counseling/support to help you quit smoking	1 (not at all likely) – 9 (extremely likely)	Analyzed separately
COVID-protective intentions next 2 weeks How frequently do you intend to do each of the following in the next two weeks if the COVID-19 pandemic continues? - Wear a face mask in public - Wash hands with soap and water - Practice social distancing	1 (never) – 4 (always) + Don't know[a]	Analyzed separately
COVID-19 information-seeking intentions - If you see a news story (on TV, newspaper, radio, Internet) reporting scientific findings related to the risk of smoking and COVID-19, how much attention would you pay to the news story? - How likely is it that you would look for more information about the risk COVID-19 for smokers?	1 (not at all) – 9 (extremely)	Analyzed separately

[a] The response category "Don't know" was treated as missing. Response categories were 1 = "Never" and "Some of the time" and 2 = "Most of the time" and "Always.'

Covariates

As possible covariates, we used standard demographic measures: gender (male vs. female), age, race (white vs. non-white), and education (high school or less vs. other). We also included other measures that might be predictive of our outcomes: smoking quit intentions at pretest (dichotomized into 1 = *Never expect to quit*/*May quit in the future, but not in the next 6 months vs.* 2 = *Will quit in the next 6 months*/*Will quit in the next month*/*Currently trying to quit*); self-reported health status at pretest (range: 1 = *poor* to 5 = *excellent*) and self-reported COVID-19 status (*never had* vs. *had or suspected to have)* at pretest. Having known someone with COVID-19 (*0 people* or *don't know* vs. *know 1-10 or more*) or heard about increased risks of COVID-19 for smokers (*heard nothing* vs. *heard about increased risks*) was assessed after message exposure.

Analysis Plan

We ran three MANCOVA models with message conditions (COVID-19 risk, smoking risk, combined risk, and control) entered as the independent variable and outcomes from sets 1-3 as dependent variables. To identify covariates for analyses, we followed the criterion of Pocock et al. (2002) and only included covariates that correlated with dependent variables at $r \geq .3$. The first MANCOVA model tested set 1 message reactions (i.e., positive and negative emotions and psychological reactance) using health status as a covariate. The second MANCOVA tested set 2 attitudes and beliefs (i.e., severity, susceptibility, self-efficacy, response efficacy for smoking and COVID-19, and COVID-19 conspiracy beliefs), adjusting for pretest smoking quit intentions and health status. The third MANCOVA tested set 3 behavioral intentions (i.e., smoking intentions, COVID-protective intentions, and COVID-19 information-seeking intentions) using pretest smoking quit intentions and health status as covariates. Bonferroni correction was used to

assess multiple comparisons in MANCOVA models. We ran three multivariate logistic regression models since the COVID-protective intention outcomes in set 3 were dichotomous (see Tables 1 and 3 for scoring info). The adjusted regression models used pretest smoking quit intentions, health status, and condition (with control as the referent) as predictors on intentions to wear masks, wash hands, and social distance in the next 2 weeks (Table 3). Significance levels for all tests were $p < .05$. All analyses were conducted with SPSS 27.

Results

Participant characteristics are shown in Table 2. The sample (N=1,004) was 18-79 (M= 40.56 years, SD = 15.01) adults who currently smoked every day or some days, 50.1% identified as male, 67.0% as White, and 36.8% as having high a school degree or less. The largest group for self-reported health status was "good" (32.2%), and the largest group for pretest smoking quit intentions was "may quit smoking, but not in the next 6 months" (43.8%). A minority of participants thought they had COVID-19 (16.5%) in the past, although most knew someone who had COVID-19 (55.7%) and had heard about the risks of COVID-19 for smokers (81.6%).

Set 1: Message Reactions

In the MANCOVA, the multivariate effect of condition was significant, Wilks' $\Lambda = .72$, $F(9, 2427) = 38.27$, $p < .001$, $\eta_p^2 = .10$. The univariate effect of condition was significant for negative emotions ($F[3, 999] = 71.87$, $p < .001$, $\eta_p^2 = .18$) and positive emotions ($F[3, 999] = 23.07$, $p < .001$, $\eta_p^2 = .07$). Pairwise comparisons showed negative emotions were significantly higher in every risk condition versus the control. Positive emotions were higher in the control than all risk conditions (see Table 2 for all MANCOVA results). Reactance was not significant at the univariate level or for differences in pairwise comparisons between conditions.

Set 2: Attitudes and Beliefs

Multivariate effect of condition was significant, Wilks' $\Lambda = .96$, $F(30, 2904) = 1.54$, $p < .05$, $\eta_p^2 = .02$. The univariate effects of condition were significant for perceived smoking severity ($F[3, 998] = 3.40$, $p < .05$, $\eta_p^2 = .01$). Pairwise comparisons showed perceived smoking severity was significantly higher in the combined risk condition versus the control condition. None of the other smoking perceptions (i.e., perceived susceptibility, self-efficacy and response efficacy), COVID-19 perceptions (i.e., perceived severity or susceptibility; self-efficacy or response efficacy), or COVID-19 conspiracy beliefs were significant at the univariate level or significantly different in pairwise comparisons between conditions.

Set 3 Behavioral intentions

Set 3: MANCOVA Results with Smoking and Information-seeking Intentions

The multivariate effect of condition was significant, Wilks' $\Lambda = .97$, $F(18, 2809) = 1.95$, $p < .05$, $\eta_p^2 = .01$. The univariate effect of condition was significant for smoking quit intentions in the next 1 month ($F[3, 998] = 3.43$, $p < .05$, $\eta_p^2 = .01$) and intentions to reduce smoking in the next 6 months, ($F[3, 998] = 3.54$, $p < .05$, $\eta_p^2 = .01$). Pairwise comparisons showed smoking quit intentions in the next 1 month were significantly higher in the combined risk condition than the COVID-19 risk condition and the control condition. Intentions to reduce the number of cigarettes in the next 6 months were significantly higher in the combined risk condition than the smoking risk and control conditions. The other smoking intentions (i.e., seek counseling and use NRT) and information-seeking intentions were non-significant at the univariate level and were not significantly different in pairwise comparisons between conditions.

Set 3: Logistic Regression Results with COVID-protective Intentions

We ran separate logistic regression models for each of the three dichotomous COVID-protective intentions (wear mask, wash hands, social distance) with condition (control as the

referent), pretest smoking quit intentions, and health status as predictors (see Table 3). In the first model with mask-wearing intentions as the outcome, exposure to the combined risk condition (vs. control as referent) predicted mask-wearing intentions (AOR = 1.97, $p < .05$) as did pretest smoking quit intentions (AOR = 1.78, $p < .01$), with intentions to quit smoking in the near future associated with greater odds of mask-wearing intentions in the next 2 weeks. In the second model, health status predicted hand-washing intentions (AOR = 0.67, $p < .01$) with higher scores on health status associated with lower odds of hand-washing intentions in the next 2-weeks. No predictors were significant in the third regression model for the social distancing outcome.

Table 2. *Sample Characteristics Overall and by Message Condition. All participants (n=1004) were currently smoking everyday or some days.*

		Treatment			
	Overall (*N*=1004) Unweighted %	**COVID-19 risk condition** (*n* = 252) Unweighted %	**Smoking risk condition** (*n* = 252) Unweighted %	**Combined risk condition** (*n* = 243) Unweighted %	**Control condition** (*n* = 257) Unweighted %
Gender					
Male	50.1	45.6	50.0	56.0	49.0
Female	49.8	54.4	49.6	44.0	51.0
Transgender	0.1	0.0	0.4	0.0	0.0
Age					
18-29	32.2	36.9	31.0	29.6	31.1
30-44	31.2	28.6	33.7	30.9	31.5
45-59	21.5	19.4	20.2	23.9	22.6
60 +	15.1	15.1	15.1	15.6	14.8
Race					
White	67.0	60.3	67.1	73.7	67.3
Black	17.3	20.6	18.7	12.3	17.5
Asian	4.4	4.4	4.0	3.7	5.4
American Indian or Alaska Native	4.0	6.3	3.6	2.1	3.9
Native Hawaiian or Pacific Islander	1.2	2.4	1.6	0.4	0.4
More than one race	4.2	4.4	3.2	4.5	4.7
Prefer not to say	1.9	1.6	2.0	3.3	0.8
Education					
High school or less	36.8	35.3	39.3	36.7	35.8
Some college	23.2	23.8	25.8	19.8	23.3
Bachelor or higher degree	40.0	40.9	34.9	43.6	40.9
Pretest smoking quit intentions					
Never expect to quit	14.7	14.7	15.1	14.4	14.8
May quit in the future, but not in the next 6 months	43.8	43.3	43.7	44.4	44.0
Will quit in the next 6 months	18.4	16.7	20.2	17.7	19.1
Health Status					
Poor	3.9	4.4	3.6	4.5	3.1
Fair	17.8	17.5	15.1	18.9	19.8
Good	32.2	31.0	32.9	32.5	32.3
Very good	28.6	28.6	29.4	23.9	32.3

Excellent	17.5	18.7	19.0	20.2	12.5
Had COVID-19	16.5	15.5	18.3	17.3	15.2
Know someone personally with COVID-19	55.7	51.2	60.3	58.0	53.3
Heard about risk of COVID-19 for smokers	81.6	79.4	77.4	85.6	84.0

Note. There were no significant differences in baseline characteristics between message conditions.

Table 3. *MANCOVA results for set 1 (message reactions), set 2 (attitudes and beliefs), and set 3 (behavioral intentions) outcomes.*

Outcomes [^]	**COVID-19 risk condition** (*n* = 252) EMM (95% CI)[*]	**Smoking risk condition** (*n* = 252) EMM (95% CI)	**Combined risk condition** (*n* = 243) EMM (95% CI)	**Control condition** (*n* = 257) EMM (95% CI)
Set 1: Message reactions				
Negative emotions	**5.31 (5.06-5.55)[a]**	**4.95 (4.71-5.20)[a]**	**5.27 (5.02-5.52)[a]**	**3.09 (2.85-3.34)[b]**
Positive emotions	**3.66 (3.40-3.93)[a]**	**3.97 (3.71-4.23)[a]**	**3.95 (3.68-4.21)[a]**	**5.10 (4.84-5.36)[b]**
Psychological reactance	3.58 (3.29-3.87)	3.62 (3.34-3.91)	3.77 (3.47-4.06)	3.42 (3.13-3.70)
Set 2: Attitudes and beliefs				
Perceived smoking severity	6.71 (6.45-6.97)	6.67 (6.41-6.93)	**6.80 (6.53-7.06)[a]**	**6.25 (5.99-6.51)[b]**
Perceived smoking susceptibility	5.80 (5.52-6.08)	5.99 (5.71-6.27)	6.09 (5.81-6.37)	5.68 (5.41-5.96)
Smoking self-efficacy	4.66 (4.41-4.91)	4.81 (4.55-5.06)	5.09 (4.83-5.34)	4.85 (4.60-5.10)
Smoking response efficacy	6.81 (6.57-7.05)	6.87 (6.63-7.11)	7.15 (6.91-7.40)	6.87 (6.64-7.11)
Perceived COVID-19 severity	6.49 (6.22-6.77)	6.48 (6.20-6.75)	6.84 (6.56-7.12)	6.68 (6.40-6.95)
Perceived COVID-19 susceptibility	4.98 (4.70-5.26)	4.69 (4.41-4.97)	4.97 (4.68-5.26)	4.71 (4.43-4.98)
COVID-19 self-efficacy	7.19 (7.00-7.38)	7.20 (7.01-7.39)	7.49 (7.30-7.68)	7.33 (7.15-7.52)
COVID-19 response efficacy	7.28 (7.07-7.50)	7.29 (7.07-7.50)	7.67 (7.45-7.89)	7.36 (7.15-7.58)
COVID-19 conspiracy beliefs:				
Experts intentionally mislead for their benefit	3.75 (3.51-4.00)	3.43 (3.18-3.68)	3.54 (3.29-3.79)	3.68 (3.44-3.93)
COVID-19 was brought into world to reduce population	4.10 (3.85-4.35)	3.86 (3.61-4.11)	4.01 (3.76-4.27)	4.17 (3.92-4.42)
Set 3: Behavioral intentions				
Smoking quit intentions next 1 month	**4.85 (4.50-5.21)[a]**	4.90 (4.55-5.26)	**5.56 (5.20-5.92)[b]**	4.89 (4.54-5.24)
Smoking intentions next 6 months:				
Reduce number of cigarettes per day	5.89 (5.60-6.17)	**5.86 (5.58-6.15)[a]**	**6.41 (6.12-6.70)[b]**	**5.84 (5.56-6.12)[a]**
Use nicotine gum, patch, or NRT	4.87 (4.55-5.19)	4.57 (4.25-4.89)	5.10 (4.78-5.43)	5.05 (4.74-5.37)
Seek counseling or support	4.48 (4.17-4.80)	4.46 (4.15-4.78)	5.00 (4.68-5.33)	4.76 (4.44-5.07)
COVID-19 information seeking intentions:				
Pay attention to news stories	6.32 (6.04-6.59)	6.29 (6.01-6.57)	6.47 (6.19-6.76)	6.00 (5.72-6.27)
Look for information on risk of COVID-19 for smokers	6.03 (5.73-6.32)	6.01 (5.72-6.30)	6.13 (5.83-6.43)	6.16 (5.87-6.45)

[*] EMM = Estimated Marginal Means, 95% CI = 95% Confidence Interval. **Bold** indicates significant difference with another condition at $p < .05$. Estimates with different superscripts in each row were significantly different at $p < 0.05$. Bonferroni procedure was used to adjust for multiple comparisons.

[^] Covariates were those that correlated at $r \geq .3$ with outcomes in a set: health status (sets 1-3), and pretest smoking quit intentions (sets 2 and 3).

Table 4. *Logistic regression results predicting intentions for COVID-protective behaviors next 2 weeks.*

	Wear a face mask in public[b] (*n* = 983)	**Wash hands with soap and water** (*n* = 979)	**Practice social distancing** (*n* = 976)
	AOR (95% CI)[a]	AOR (95% CI)	AOR (95% CI)
Message Condition			
COVID-19 risk	1.07 (0.66-1.74)	1.01 (0.51-1.99)	0.89 (0.49-1.64)
Smoking risk	1.20 (0.73-1.97)	1.00 (0.50-1.97)	0.78 (0.43-1.41)
Combined risk	**1.97 (1.13-3.46)**	1.63 (0.75-3.55)	1.66 (0.82-3.39)
Control	Referent	Referent	Referent
Pretest smoking quit intentions[c]			
Will quit in the near future	**1.78 (1.20-2.64)**	1.66 (0.97-1.86)	1.54 (0.96-2.47)
Not planning to quit in the near future	Referent	Referent	Referent
Health status[d]	0.87 (0.73-1.03)	**0.67 (0.52-0.86)**	0.87 (0.71-1.07)

[a] AOR= Adjusted Odds Ratio, 95% CI = 95% Confidence Interval. **Bold** indicates significance at $p < .05$.
[b] All COVID-protective intentions were scored as 1 = "Never" and "Some of the time" vs. 2 = "Most of the time" and "Always" with "Don't know" treated as missing.
[c] Pretest smoking quit intentions were dichotomized as 1 = "Never expect to quit" and "May quit in the future, but not in the next 6 months" vs. 2 = "Will quit in the next 6 months," "Will quit in the next month," and "Currently trying to quit."
[d] Health status was scored continuously from 1 = "poor" to 5 = "excellent."

Discussion

This study experimentally tested messages about COVID-19 risk, smoking risk, and combined risk versus non-risk controls with a sample of U.S. adults who smoke. Results showed that exposure to the combined risk messages elicited higher perceived severity of smoking-related disease than the control messages. Similarly, the combined risk condition resulted in greater intentions to quit smoking in the next 1 month (vs. COVID-19 risk condition) and intentions to reduce smoking in the next 6 months (vs. smoking risk and control conditions). In addition, exposure to the combined risk messages (vs. control) predicted greater likelihood of mask-wearing intentions in the next 2 weeks. Finally, each risk condition resulted in greater negative emotions and lesser positive emotions than the control condition. These results add evidence to earlier work testing smoking and COVID-19 health messages (Grummon et al., 2020; Pettigrew et al., 2021) and inform public health communication and policy during the COVID-19 crisis, especially regarding novel strategies for motivating smoking cessation.

Our results add to the literature by assessing the effects of messages about the combined risk of smoking for COVID-19 severity on smoking outcomes. Exposure to the combined risk messages led to higher intentions to quit smoking in the next month (vs. COVID-19 risk) and reduce smoking in the next 6 months (vs. smoking risk and non-risk control). These results confirm and add to research where people who smoke perceived combined risk messages as more effective at discouraging smoking than generic messages (Grummon et al., 2020; Pettigrew et al., 2021).

Describing the risk of smoking for COVID-19 severity could inform health campaigns aimed at people who smoke. For example. U.S. agencies like the Centers for Disease Control are actively messaging on the risks of smoking for COVID-19 severity by recommending that

people who smoke quit (Centers for Disease Control and Prevention, 2021). While the efficacy of such appeals is unknown—and a topic of future research—our results suggest combining risks of smoking for COVID-19 severity can enhance smoking quit intentions, which are theorized to influence smoking behaviors (Fishbein & Ajzen, 2011; Noar et al., 2016). Although our study did not capture smoking behaviors, our results highlight a novel strategy for public health and tobacco control messages promoting smoking cessation through the threat of COVID-19.

Messages about more severe COVID-19 for people who smoke can be targeted at people who smoke and at the general public for two reasons. First, friends and family of people who smoke can pass this information to their loved ones, motivating them to quit smoking. Such social concerns, like pressure from the family, has been listed as the second most important motivation to quit after health concerns (McCaul et al., 2006). In addition, messages about more severe COVID-19 for people who smoke can be used as prevention messages for people who are susceptible to smoking, and future studies should investigate that.

This study also assessed COVID-protective intentions related to the combined risk of smoking and COVID-19. To our knowledge, this relationship has not been investigated in the literature. Results showed that exposure to the combined risk messages (vs. non-risk control) predicted greater odds of mask-wearing intentions in the next 2 weeks (Table 3). One interpretation of this finding is that the additive effect of smoking and COVID-19 risk messages were stronger on mask-wearing intentions than COVID-only risk messages. The pattern of results suggests a benefit of combining risk information for smoking and COVID-19 to motivate people who smoke to engage in protective behaviors preventing both health risks. To our knowledge, this is the first study to demonstrate that messages about the increased risk of smoking for COVID-19 outcomes impacted both smoking and COVID-protective intentions.

These findings could have policy implications by showing the utility of messaging on the combined risks of smoking for COVID-19 severity to target COVID-19 outcomes. Research in this area could inform public policy in developing countries bearing a high rate of tobacco use and being hit hard by the COVID-19 pandemic. However, our preliminary results should be replicated with different samples in other health communication contexts and with different message stimuli. Future studies should explore whether these messages can help motivate vaccination intentions.

In addition, we found that individual baseline health perceptions predicted lesser odds for certain COVID-19 protective intentions. Specifically, better-perceived health status was associated with lower odds of hand-washing intentions. These findings might be explained by research on compensatory health beliefs wherein a person believes that healthy behaviors (e.g., good general health) equalizes a negative health behavior (e.g., not washing hands with soap and water; Knäuper et al., 2004). Unfortunately, this study's data did not allow for assessing this speculation, which might be a topic for future research.

Our study demonstrated that exposure to risk messages resulted in greater negative emotions than the control condition. Past research has shown that public health campaigns using strong fear appeals were considered more persuasive (Witte & Allen, 2000). Research has shown that fear and disgust aroused from exposure to smoking warning messages can motivate intentions to quit smoking (Hammond, 2011). Fear of COVID-19 has also been associated with intentions to quit smoking (Gold et al., 2021). Another paper analyzing the data reported here found that exposure to the combined risk messages (vs. smoking risk) resulted in participants feeling more fearful, which fully mediated the effect of message exposure on intentions to quit smoking (Duong et al., 2021). Overall, results supported growing scientific evidence that

negative emotional responses to messages highlighting the severe risk of COVID-19 disease to smokers predict intentions to quit smoking (Duong et al., 2021; Gold et al., 2021). As a policy implication, these results indicate that governmental agencies (e.g., the Centers for Disease Control) trying to influence smoking cessation could use emotion-evoking warning messages about the risk of smoking for COVID-19 severity in-line with best-practices for persuasion in public health campaigns (Witte & Allen, 2006).

Limitations

This study has several limitations. First, the sample was not representative, thereby limiting our generalizability. Second, outcomes were measured at one time, and it is unknown how message effects may (or may not) have decayed longitudinally. Third, the context of the pandemic has changed in several ways since our data collection, including surges of increased infections and deaths in the U.S., a presidential election largely centered on COVID-19, and the approval and administration of several COVID-19 vaccines. It is unclear how the current COVID-19 context, including the latest discovery of the Omicron variant, might influence combined risk messages about smoking and COVID-19 severity. Fourth, and finally, our study focused on behavioral intentions and not actual behaviors, although intentions are the most reliable predictors of behaviors (Fishbein & Ajzen, 2011). Still, future research should investigate the relationship between health intentions after exposure to combined risk messages and downstream smoking and COVID-protective behaviors.

Conclusion

Our experimental test of smoking and COVID-19 risk messages found several important results for how people who smoke might respond to combined risk messages. Messages focused on the role of smoking to make COVID-19 worse were most effective at increasing intentions to

quit smoking in the next 1 month and reduce smoking in the next 6 months. Exposure to the combined risk messages was associated with greater odds of COVID-protective intentions, such as wearing a mask in the next 2-weeks. These effects on smoking and COVID-protective intentions were not found in the other message conditions, which suggested a possible additive effect of combining the risk of smoking with increased severity of COVID-19 in health warning messages. Although this work is preliminary, it serves as a steppingstone to expand tobacco control research to the context of infectious diseases that might compound smoking-related morbidity and mortality. Much research is still needed to understand how smokers react to the COVID-19 risk to leverage public health messaging encouraging them to quit smoking for good.

Declaration of Competing Interests

None declared.

Ethics Approval

This study was approved by the Georgia State University Institutional Review Board (H19055).

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Authors' Contributions

LP, ZBM, and HD conceptualized the study and developed the study protocol. ZBM and LP

conducted the statistical analysis. ZBM wrote the first draft of the manuscript.

All authors contributed to the writing and revisions and approved the final version of the manuscript.

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Figure 1. *Example images and text for the experimental message conditions*.

COVID-19 Risk Condition	Smoking Risk Condition
35-year-old husband, father leaves heart-wrenching goodbye before dying from coronavirus His children won't remember him. They're too young. His wife is now facing the unfo reality of single-parenthood. But David Neely wanted to make sure the family he left behind always knows how mu meant to him – how much he loved them. So, the day before he was placed on a ventilator, the 35-year-old grabbed his phone an writing. Katie Neely found the note when she collected a bag of his belongings from th Connecticut hospital where David died alone. "I love you guys with all my heart and you've given me the best life I could have ever I am so proud to be your husband and the father to Cooper and Penny," David wrote.  "It all happened so fast." Kat "David was fighting for his l days of getting sick, and he s final 20 days on a ventilator. Public health experts recomm avoiding close contact with p are or might be sick and was often with soap for at least 2 Wearing masks in public pla helps slow the spread of the	**Smoking and risk factors for lung cancer** Smoking is the number one risk factor for lung cancer, according to Dr. David Gerber, a professor of internal medicine at the University of Texas Southwestern Medical Center. "About 85 percent of lung cancer diagnoses are in smokers." Lung cancer is the leading cause of cancer death in the United States. The chemicals in cigarette smoke cause inflammation in lungs and damage to DNA. Because smoking leads to mutations and inflammation, it's a "perfect storm" for causing lung cancer. Annette (pictured here) smoked. She went to the doctor because she was having trouble breathing. "It took multiple doctor's visits, all kinds of X-rays, and then a PET/CT scan to uncover lung cancer." Her lung had to be surgically removed. If you quit smoking, your body begins healing immediately. As lungs heal, it becomes easier to breath, and former smokers notice less coughing and shortness of breath. Health care professionals can be a good source of info on quitting. Cessation counselors are effective. Nicotine patches help. Support groups are also helpful. Many resources are free or low cost. 
Combined Risk Condition	**Control Condition**
Minnesota man, 37, dies from coronavirus: 'He died all alo A 37-year-old Minnesota man who died from the coronavirus is being mourned by Ann Neville said her son died Saturday, two days after she drove him to the emerg started feeling sick a few weeks earlier. "It's very hard," she said. "No one was allowed to go in with him or be with him o touch him. He died all alone. I'm still baffled by all of this. I didn't get to say I lov didn't get a hug. Nothing." Jack Neville was from Stacy, Minn., and the father of a 7-year-old boy. He was als outdoorsman who loved to fish. The mother said she was worried about her son having the virus because he smoke The coronavirus attacks the lungs and researchers report that smoking increases risk for complications from COVID-19 infection. Health experts advise smokers to quit smoking to reduce the risk of COVID-19. Quitting tobacco is challenging, but there are free resources available from the CDC and other sources. Smokers can call the Quitline to talk to an expert and choose an effective option to quit smoking or get quitting help online. 	**Whale Facts: The Blue Whale** Whales roam all of the world's oceans, communicating with complex and mysterio Despite living in the water, whales breathe air. A thick layer of fat called blubber insulates them from cold ocean waters. Some whales are known as baleen whales, including blue, right, bowhead, sei, and This refers to the fact that they have special bristle-like structures in their mouths (that strain food from the water. Other whales, such as beluga or sperm whales, hav The blue whale is largest animal on the planet and can reach lengths of more than weigh up to 200 tons—as much as 33 elephants.  The blue whale has a hea Volkswagen Beetle. Its st hold one ton of krill and i about four tons of krill ea Blue whales are the loude Earth and are even louder engine. Their calls reach while a jet reaches 140 d whistle can be heard for l miles and is used to attrac whales.